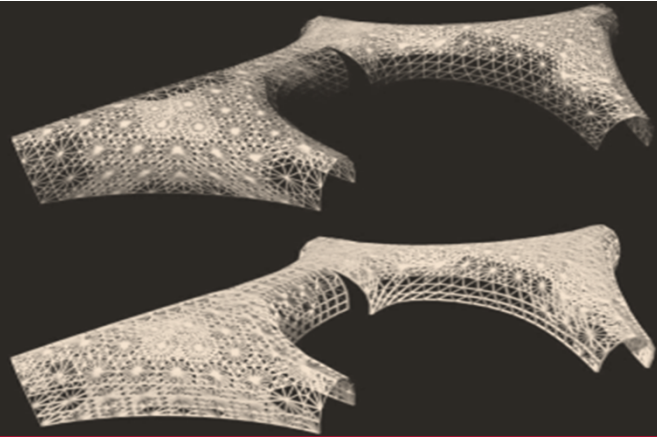


IDC DESIGN INNOVATION (DI) CREATIVE PROCESS & OPPORTUNITIES



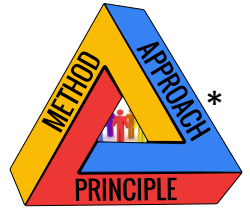
DI
Design Innovation

**SUTD-MIT
INTERNATIONAL
DESIGN
CENTRE (IDC)**
Innovation Ready Design

SUTD
SINGAPORE UNIVERSITY OF
TECHNOLOGY AND DESIGN

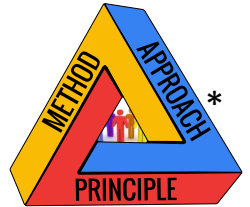
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Design Innovation (DI) Map: People Methods Process Principles



Design Innovation (DI): Our design process is *user centered* and begins with execution of specific *design methods*. These methods guide activities that lead to desired outcomes. The selection of methods, and transition between specific *methods* is governed by a *process* or approach. Our *4D process* provides an order of action while allowing for *sprints, scrums and customization* in the overall process. Finally, a *culture of design* is grown organizationally through ubiquitous *mindsets* and '*principles.*' These *principles* are cherished and adopted into our design community via execution of the methods and approach.

Design Innovation (DI) Map: People Methods Process Principles



People are our focus as individuals, groups, teams, organizations, communities, cities, and nations. Our focus is on empathy, co-creation, and societal value.

Methods are well-defined, short term activities with a specified action set and an expected format of outcome. (e.g. 6-3-5, or journey mapping).

Process or approach guides overall team and organizational design (e.g., design engineering, systems engineering, or design thinking). They also govern the transition between individual methods.

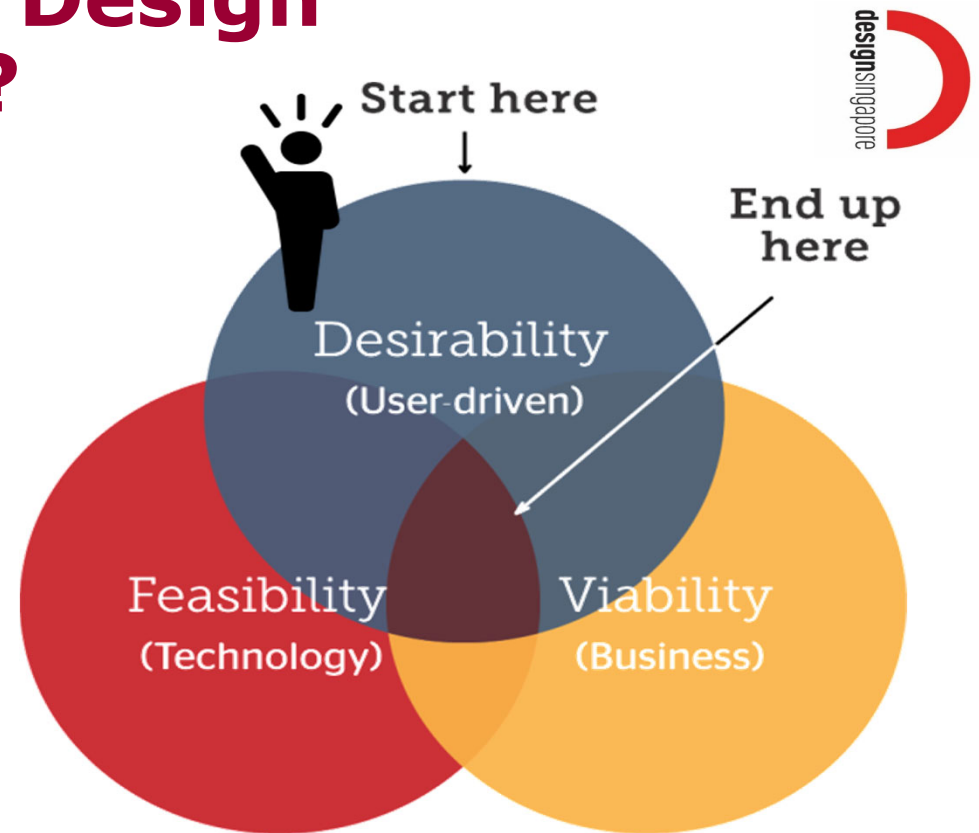
Principles are ubiquitous best practices, or mindsets, to guide the way in which the designers think, communicate, and decide. They provide insights on intangible best practices. (e.g. embrace ambiguity).

** The Escher "D" and Penrose triangle are symbolic of the IDC moving into new dimensions through Innovation Ready Design*

What is **Innovation by Design** or **Design Innovation**?

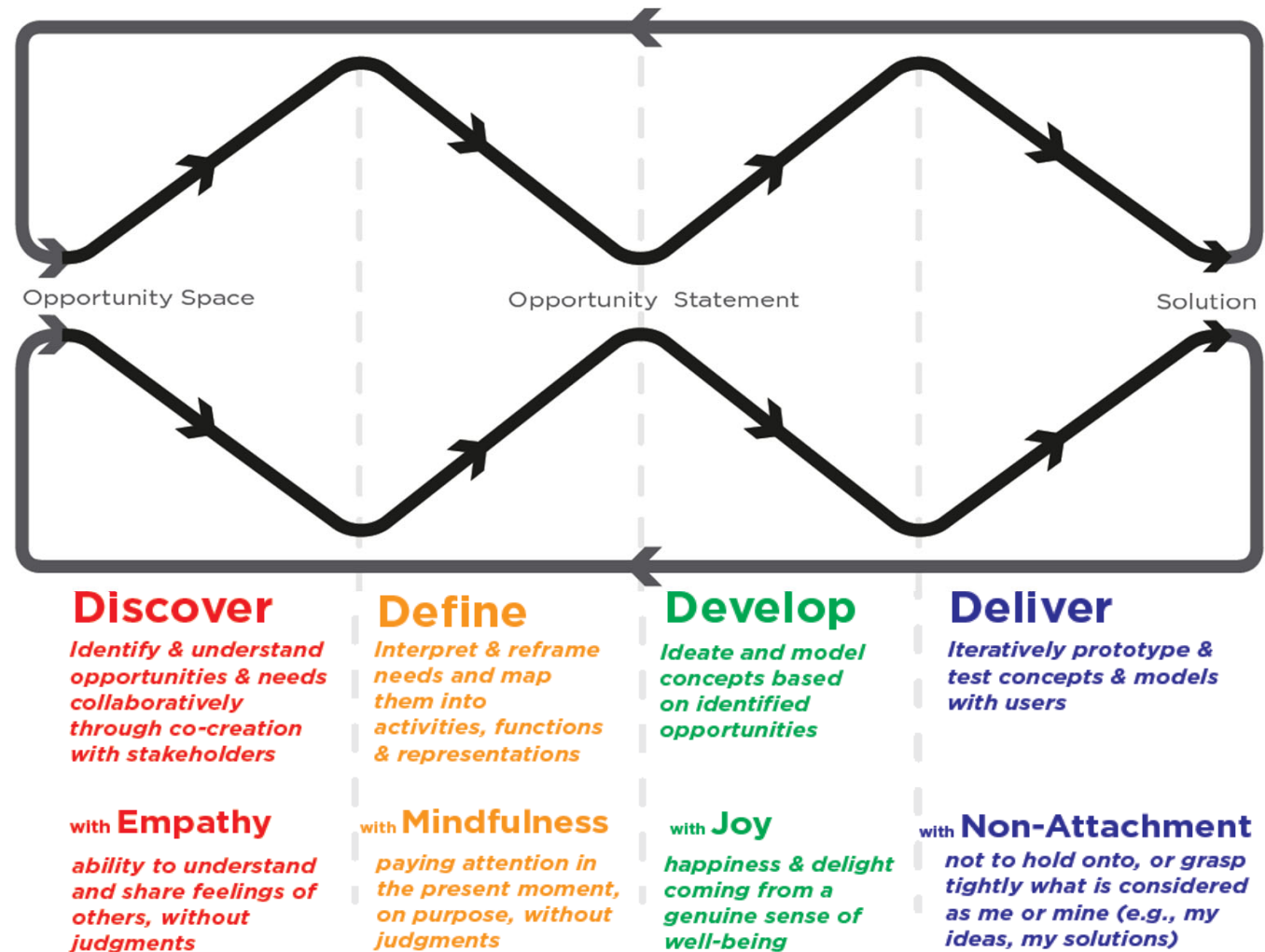
A programme that helps organisations use design as a tool for **strategic impact** and **organisational transformation**.

The design approach starts with a focus on **what the user and organization really needs and wants**.



IDC: People, Methods, Process, Principles

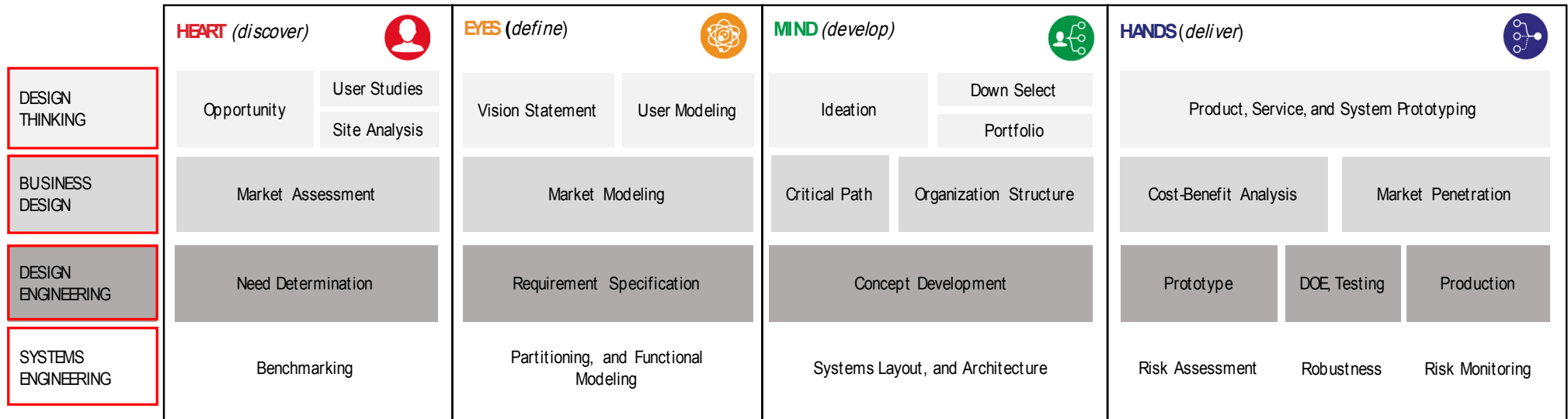
The 4Ds



IDC: People, Methods, Process, Principles

The 4Ds: Integrating Design Thinking, Business Design, Design Engineering and System Engineering

DESIGN INNOVATION:



IDC DESIGN INNOVATION (DI) CREATIVE PROCESS & OPPORTUNITIES

DISCOVER *Heart*



DEFINE *Eyes*



DEVELOP *Mind*



DELIVER *Hands*



Key Methods: Design Thinking and Design Engineering (Front-End)

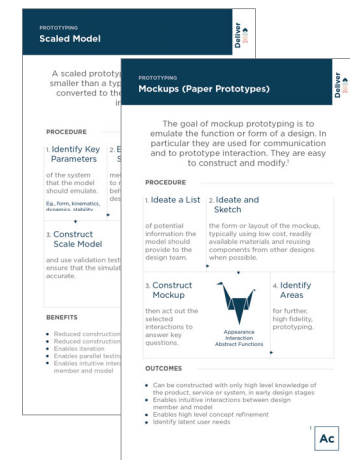
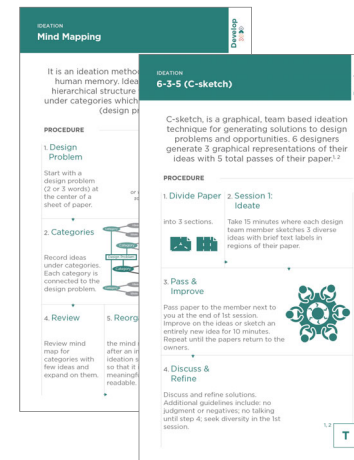
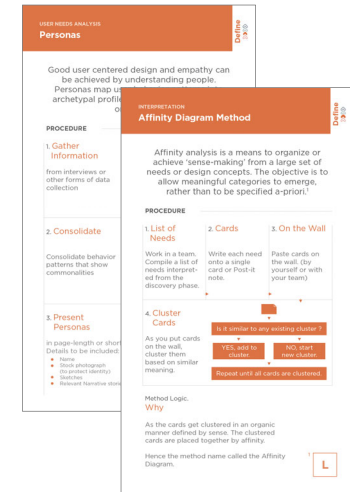
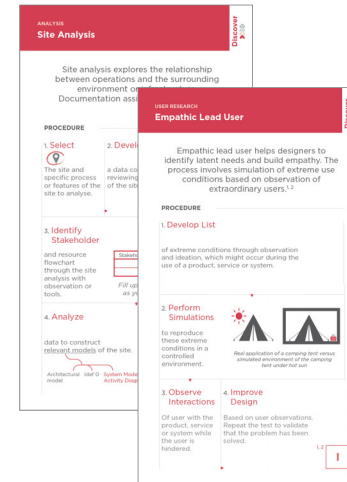
CN Analysis Contextual Needs Journey Mapping	Mission Statement Black Box Activity Diagram Affinity Analysis	C-Sketch Design by Analogy Word Tree Mindmapping	Prototyping User-Validation Scaled Prototypes Iterative Prototypes	Required
Likes/Dislikes Multisensory Analysis Articulated Use Surveys	Personas Functional Modeling Workflow Benchmarking	Bio-Inspired Brainstorming Co-Creation Morphological Matrix SCAMPER	Isolated Subsystem Mock-ups Parallel Testing Requirement Relaxation Design of Experiment Testing (Spiral Plan)	Recommended
Site Analysis Lead User Scenarios Focus Group Empathic Lead User	Specifications Sheet Want/Needs Requirements Document Background Research	Pugh Chart TRIZ Storyboarding Deep-dives	Paper Prototyping	Extended

IDC: People, Methods, Process, Principles

Phase	Cluster	Methods
Discover (heart) 	Opportunity	5 Why's, ethnographic research, co-design, design journal, reverse engineering, patent mapping
	User studies	ethnography, videography, journey map, semantic enquiry, scenarios
	Need Determination	user interview, likes/dislikes, contextual needs analysis, focus group, empathic lead user
	Site analysis	multi-sensory site analysis, observation, videography, architectural site analysis
	Market assessment	market research, PEST(EL) analysis
	Benchmarking	technology matrix, petri-net, risk management process, FRACAS, risk scope, field return and warranty analysis,
Define (eyes) 	Vision statement	mission statement, hierarchy of purpose, How Might we
	User Modeling	affinity diagram, scenarios, personas, activity diagram
	Market Modeling	SWOT analysis, Porter's 5 forces, lean startup toolkit, McKinsey's 7S, business model canvas
	Requirement Spec.	Ishikawa diagram, Mission statement, Background research, Technology Matrix
	Functional Modeling	Partitioning, Markov decision chain, IDEF0, cross-functional flowchart, influence diagram, hours of quality
Develop (mind) 	Ideation	external idea search, mind-mapping, Wordtree (design by analogy, DBA), Historical Innovators, AskNature (DBA), S.C.A.M.P.E.R.,
	Downselect	Pugh chart, pairwise comparison, design structure matrix, TRIZ
	Portfolio	concurrent engineering method, product platforms, commonality-differentiation plan, probabilistic graphical models
	Critical Path	critical path method, disruptive innovation lens, blue ocean toolkit, beach head strategy, risk acceptance, Real? Win? Worth?
	Organization Structure	Mintzbergs organizational configuration, business model organization navigator, design pattern for human system
	Concept Development	C-Sketch, Parallel Sketching, morph matrix, TRIZ, CMEA, Design for Transformation
Deliver (hands) 	Systems Layout, and Architecture	design standards, systematic layout planning, set covering, customer/human resource relationship management, simplex algorithm, product architecture
	Product, Service, and System Prototyping	paper prototyping (mockups), product service system prototyping, service prototype
	Cost Benefit Analysis	return-on-investments (NPV, IRR), break even analysis, cost-benefit analysis, cash flow prediction analysis, value proposition
	Market Penetration	first 1000 users, product champion, B2B marketing, ambidextrous organization
	Prototype	Prototyping Strategy, Empirical Similitude, pre-production prototype, Isolated Subsystem Testing,
	DOE, Testing	DOE, Safety plan and review, Reliability and Field testing, EMS development, Standards testing
	Production	Design for manufacturing, Robust Design, Taguchi methods, sensitivity analysis,
	Risk Assessment	life cycle analysis, risk treatment, discrete choice, risk communication and risk awareness consultancy
	Testing	load strength analysis, finite element modeling, subtract and operate, poka-yoke, accelerated stress testing, force flow analysis, subtract and operate
	Robustness	state-space analysis, guidelines for green design (design for X), design of experiment, Hardware in the Loop (HIL)
	Production	principles of lean, Kanban, monitoring and review, safety plan and review
	Risk Monitoring	failure modes and effects analysis, maintainability analysis, event tree, fault tree, failure probability plot, HAZOPS

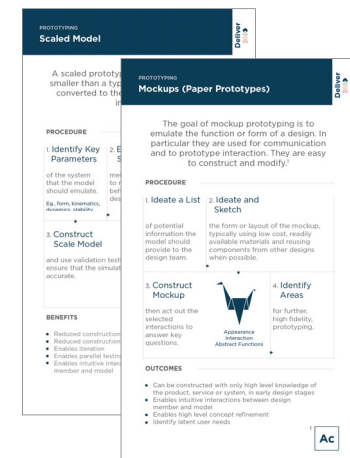
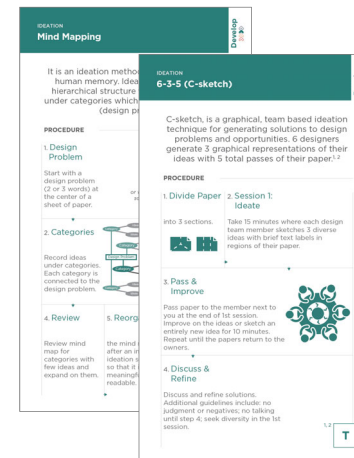
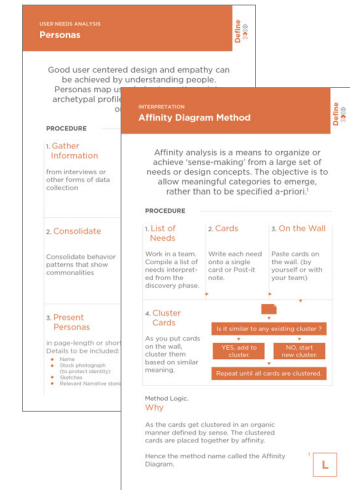
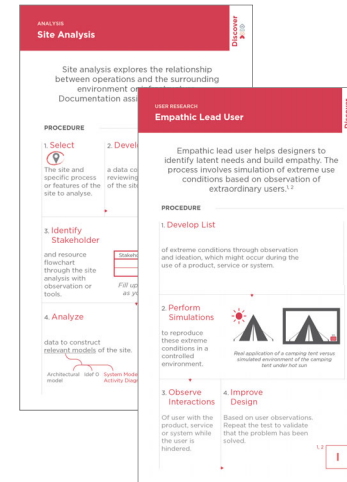
Signature Designs Design Cards

- The Design Innovation cards are highly representative of the IDC's approach to design.
- The cards represent bite-sized yet complete representations of a broad array of both advanced technical engineering methods for design, as well as empathic user centered approaches.



Signature Designs Design Cards

- The objective of these cards is to provide access to advanced design and engineering methods in a way that both experienced and novice designers can benefit from.
- The IDC design cards are a standard tool deployed in professional development workshops and design guidance and consultation.



IDC: People, Methods, Process, Principles The 4Ds

USER RESEARCH
Empathic Lead User

Empathic lead user helps designers to identify latent needs and build empathy. The process involves simulation of extreme use conditions based on observation of extraordinary users.^{1,2}

PROCEDURE

- 1. Develop List**
of extreme conditions through observation and ideation, which might occur during the use of a product, service or system.
- 2. Perform Simulations**
to reproduce these extreme conditions in a controlled environment.
Real application of a camping tent versus simulated environment of the camping tent under hot sun
- 3. Observe Interactions**
Of user with the product, service or system while the user is hindered.
- 4. Improve Design**
Based on user observations. Repeat the test to validate that the problem has been solved.

1,2 I

DESIGN METHOD CARDS

OUTCOMES

- Internal structures
- User flows
- System structures
- System flow and checkpoints

EXAMPLE SITE ANALYSIS

Model of user flow within a floorplan

Model of travel distance with a heatmap

This heatmap models the path length taken by parcels stored in each room (squares). Each parcel travels from the entrance (blue line) to the exit (red line). The room colour depicts total distance travelled by the parcel.

CONCEPT GENERATION
Co-creation

In co-creation or co-design, the person who will eventually benefit from the design process is included as a member of the design team. They play an active role in the project development.¹

PROCEDURE

- 1. Establish**
the most important challenges and pain points.
- 2. Brainstorm**
Use brainstorm methods to solve these challenges.
- 3. Iterate Collectively**
on the solution concepts generated.

KEY COMPONENTS

- Quick Improvement Cycles**
 - Quick improvements of concepts.
 - Inclusion of multiple stakeholders.
 - Breaks traditional roles and features.
 - Extract user needs upfront.
- Problem-Solution Linkage**
 - Connect need finding to solutions directly.
 - Higher accuracy in need finding.
 - Keep the design team 'grounded'.

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IDEATION
Design by Analogy (WordTree Method)

Design by analogy, is a process of transferring design solutions across different design domains (a.k.a. design by metaphor).¹

PROCEDURE

- 1. Formulate**
the Design Problem Statement.
- 2. Decompose Statement**
into keywords, functional elements and problem descriptors.
- 3. Restructure Problem**
Use any of the following methods to aid the process of problem restructuring:
 - 6-3-5-Why (existing problem)
 - Visualisation
 - Functional Basis
 - Thesaurus
- 4. Analogous Solutions**
Use these new terms to search for analogies in other domains using any of the following tools:
 - Ask Nature
 - Search Database
 - Field Research
 - Personal Experience
- 5. Generate Ideas**
and try to create new "very different" ideas, sketch it on the template.

Related Cards
T, V, U, R

CONCEPT GENERATION
Parallel Sketching

Parallel sketch is a design ideation tool to enable rapid development of many variations on a design. A basic template or cell is preloaded to structure and accelerate ideation.¹

PROCEDURE

- 1. Define**
the basic optical framework of your product, system, or service.
From left to right: The bottom, top and front views of a ring (the product)
- 2. Create Templates**
Create a number of empty templates using the framework from step 1.
- 3. Sketch 5**
Try to sketch at least 5 or more different ideas on the templates.
- 4. Review Sketches**
and try to create new "very different" ideas, sketch it on the template.
- 5. Repeat**
Repeat all the steps until you have populated the matrix, repeats as needed.
A printed out template from step 1 at a Matrix

W

IDEATION
6-3-5 (C-sketch)

C-sketch, is a graphical, team based ideation technique for generating solutions to design problems and opportunities. 6 designers generate 3 graphical representations of their ideas with 5 total passes of their paper.^{1,2}

PROCEDURE

- 1. Divide Paper**
into 3 sections.
- 2. Session 1: Ideate**
Take 15 minutes where each design team member sketches 3 diverse ideas with brief text labels in regions of their paper.
- 3. Pass & Improve**
Pass paper to the member next to you at the end of 1st session. Improve on the ideas or sketch an entirely new idea for 10 minutes. Repeat until the papers return to the owners.
- 4. Discuss & Refine**
Discuss and refine solutions. Additional guidelines include: no judgment or negatives, no talking until step 4; seek diversity in the 1st session.

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DESIGN METHOD CARDS

TEMPLATE STRUCTURE

EXAMPLE: COMMUNICATION DEVICE

	Real	Win	Worth It
Keypad Phone	✓	✓	✗
Headset	✓	✗	✗
Flipless Phone	✓	✓	✓
Holographic Conference	✗	✓	✓

DESIGN METHOD CARDS

TYPES OF MOCKUPS

EXAMPLE MOCKUPS: WORKSHOPS

Mockup prototype for an energy usage monitoring system

Designers using a mockup to share ideas for microscope stage assembly

DESIGN METHOD CARDS

TEMPLATE STRUCTURE

The prototyping strategy space has several variables. An individual prototype might be scaled, full-sized, virtual or physical, at others. A prototyping strategy can consist of multiple iterations or concepts tested in parallel.

EXAMPLE STRATEGIC PROTOTYPING: MEDICAL DEVICE

The first iteration of a related requirement mockup prototype for laparoscopic scanner to test user interaction.

ASSESSMENT
Risk Management Process

Risk management process is a proactive approach to mitigate risk during project management. It helps to recognize and manage events that threaten the likelihood of a project's success.¹

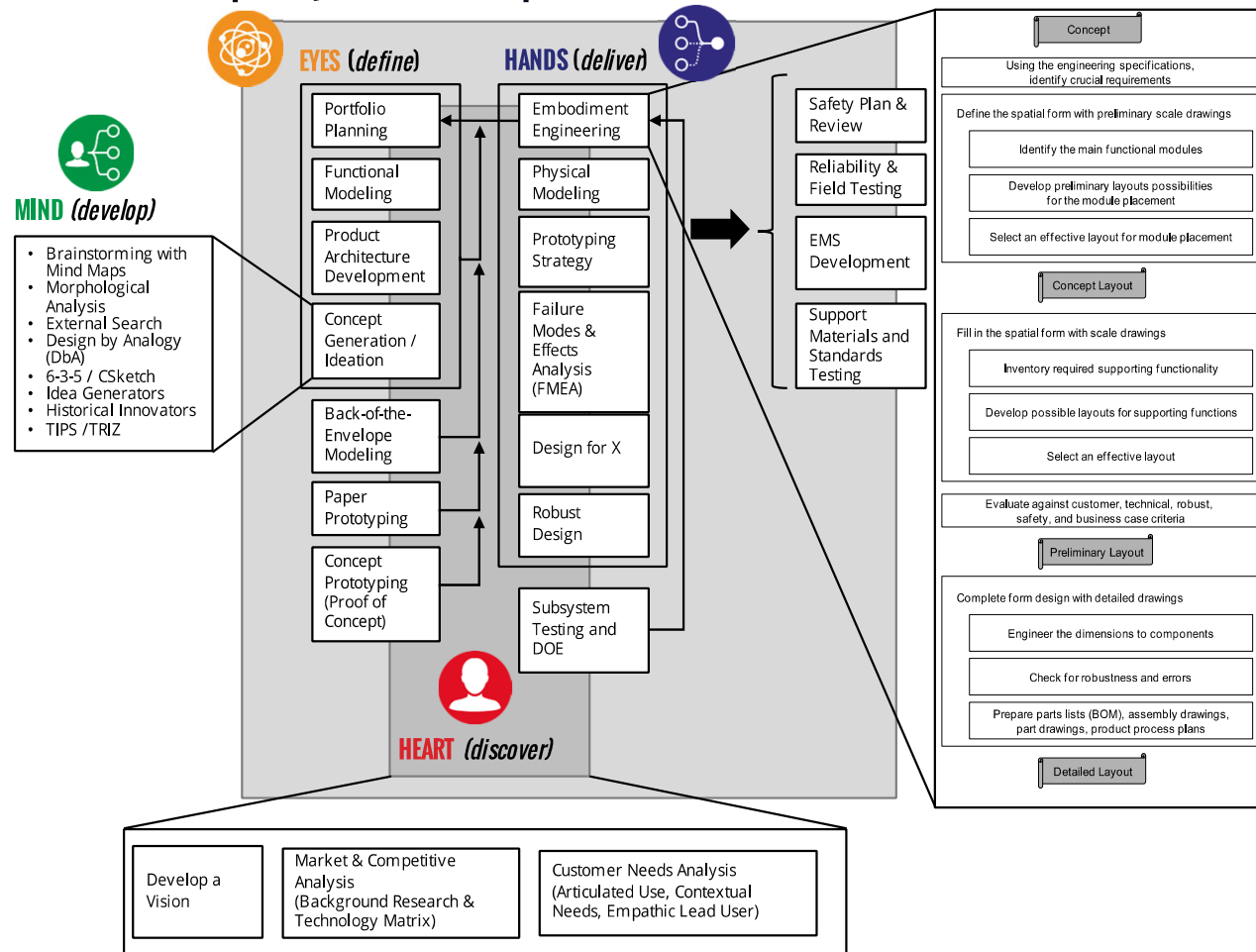
PROCEDURE

- 1. Identify Risks**
Identify a list of possible risks through brainstorming, problem identification and risk profiling.
Are the requirements stable or risky? Do the design depend on unrealistic or optimistic assumptions? Is the schedule dependent upon the completion of other projects? Are quality considerations incorporated in the design?
- 2. Rate it**
List each of the risk concerns on the assessment form then rate the likelihood and impact.
- 3. Probability Matrix**
Create a probability and impact matrix. Manage risks by identifying the most critical concerns from the matrix.
- 4. Risk Mitigation**
Develop a risk mitigation strategy.
Impact x Probability = Detection Difficulty = Risk Value

Ab

IDC: People, Methods, Process, Principles *The 4Ds*

Innovative Rapid System Development



IDC DESIGN INNOVATION (DI) CREATIVE PROCESS & OPPORTUNITIES

DI
Design Innovation

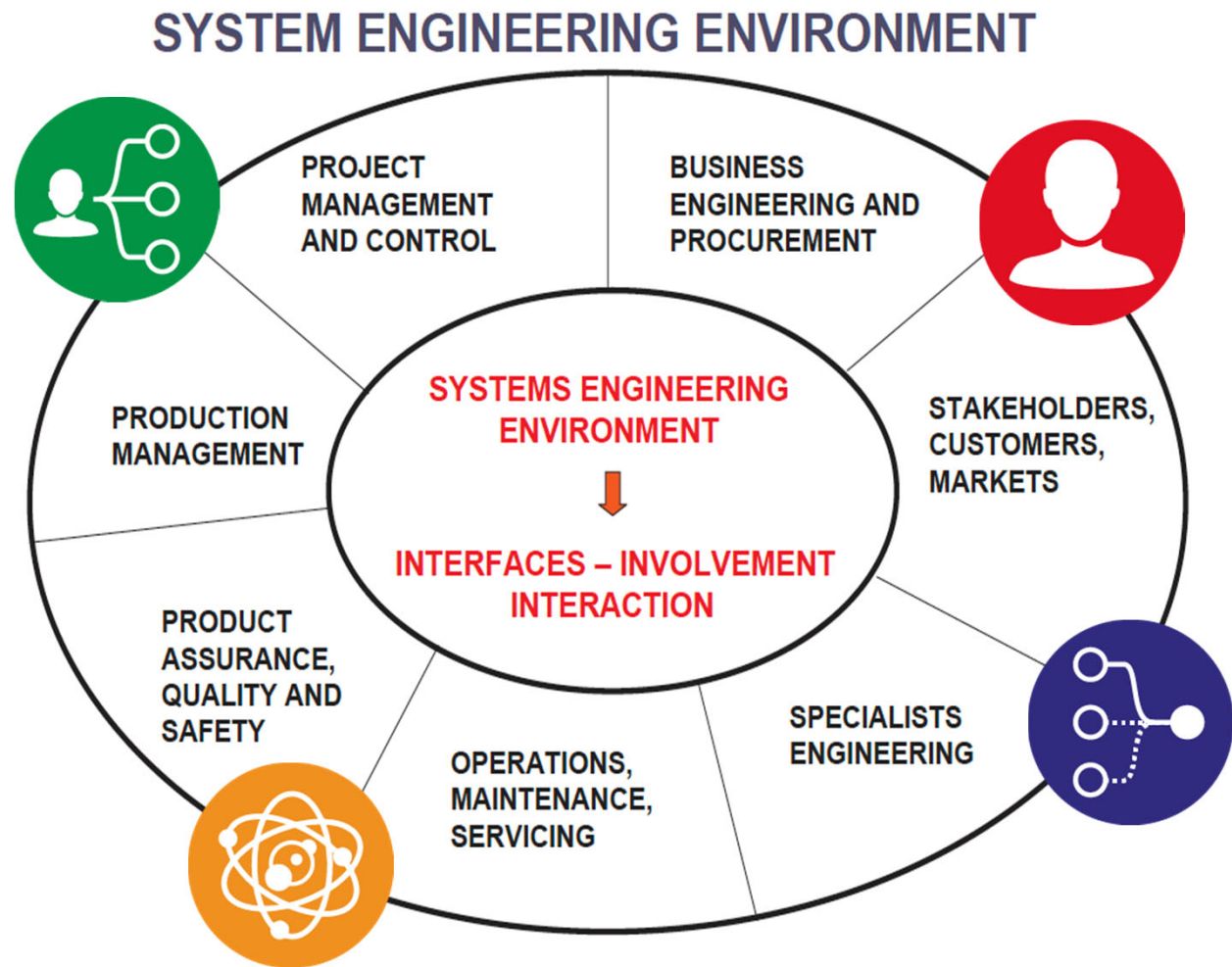
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IDC: People, Methods, Process, Principles

Ref. Prof H Stoewer



IDC: People, Methods, Process, *Principles* (sample) The 4Ds

Creativity Throughout.

Creativity should occur not only during ideation but throughout the entire design process.

Embrace Open Resources.

Open source, open data, open innovation, sharing and freedom to explore, are essential components of healthy collaboration and the emergence of novel ideas.

Make, Test, Learn, Repeat.

Willingness to turn ideas into action and rapidly iterate after testing is essential to design. Hands-on experience provides valuable lessons that cannot be replaced.

Appetite for Ambiguity.

It is essential to accept that the outcome of an innovation process is unknown at the start and novel solutions will push our comfort zones.

Adaptive Pathways.

Adaptation is required from the beginning of a design process. A design team must reflect on their process and adjust it dynamically.

Free Space for Blue Skies.

A design environment should provide free space to explore radical ideas without constraints. Trust, infrastructure, and culture must coincide to support this activity.

Empathy for all.

Empathy is required so that true needs are uncovered to open the potential for a desirable outcome that impacts stakeholders in a positive way.

Curiosity for Context.

Understanding stakeholders is dear to the innovation process. Needs assessment requires not only an empathy for a user as a person but also a detailed knowledge of their situations and environment.

Pride in art, Art in craft, Craft in pride.

Taking pride, and placing effort into the quality of construction and aesthetic is a core component of design. Aesthetic craftsmanship should not be taken for granted.

Expressive Collaboration.

Exchange of perspectives must happen at a deep level within the design team and between all stakeholders.

Celebrate both the Quantitative and Qualitative.

Utilizing qualitative and quantitative data allows the design team to make observations that are both valid and insightful.

Also Can.

A positive and optimistic attitude is essential in discovering out-of-the-box ideas. Optimism, in supporting other's ideas, is equally important for team coherence.

**“CREATIVITY
IS PIERCING
THE MUNDANE
TO FIND THE
MARVELLOUS.”**

- BILL MOYERS

Thank You!





“The IDC is a **game changer in design and science. I am within **arms reach of architects, designers, engineers, and computational analysts** at my desk in the design innovation space”**

- Adam Gilmour, CEO, Gilmour Space Technologies

Thank You!